Stormwater Management Conceptual Designs

Shawsheen River Watershed-Based Plan

February 2025

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Disclaimer:

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INTRODUCTION

This report presents conceptual designs for four stormwater control measures (SCMs)[1] at two sites within the Shawsheen River Watershed. These sites and the proposed SCMs were selected through a process of desktop analyses, field reconnaissance, and stakeholder consultation. This work is part of a larger effort by the Merrimack River Watershed Council (MRWC) and the Merrimack Valley Planning Commission (MVPC) to develop a watershed-based plan (WBP) for the Shawsheen River.

The WBP study area focuses on the lower segments of the Shawsheen River flowing through Tewksbury, Andover, North Andover, and Lawrence to its confluence with the Merrimack River. The Shawsheen River and its tributaries are classified in the Massachusetts Surface Water Quality Standards (314 CMR 4.00) as Class B waters with warm water fisheries, designated as habitat for fish, other aquatic life, and wildlife and for primary and secondary contact recreation. The lower river segment (MA83-19) is listed on the Massachusetts Integrated List of Waters (2022) as impaired due to benthic macroinvertegrates, curly-leaf pondweed, fish passage barrier, *Escherichia coli* (E. coli), and fecal coliform. The next upstream segment (MA83-18) is listed as impaired due to curly-leaf pondweed, fecal coliform, E. coli, and dissolved oxygen. These segments are covered by the 2002 Bacteria Total Maximum Daily Load (TMDL) for the Shawsheen River Basin, which identifies discharges from municipal separate storm sewer systems as a source of E. coli. The Shawsheen River is a tributary to the Merrimack River (MA84A-04), which is impaired due to E. coli, PCBs in fish tissue, and total phosphorus (TP). As permittees under the Massachusetts General Permit for Stormwater Discharges from Small Municipal Separate Storm Sewer Systems (MS4 Permit), Tewksbury, Andover, North Andover, and Lawrence are required to develop phosphorus source identification reports and retrofit evaluations, and to implement municipal stormwater retrofits to reduce phosphorus loading.

Under contract with MRWC, HW completed an assessment to identify potential stormwater retrofits to reduce pollutant loading to the Shawsheen River and its tributaries. The assessment consisted of desktop analysis and stakeholder discussions, field visits to priority sites selected by stakeholders, and recommendations for SCMs and pollutant source controls at those sites. Our team estimated planning-level pollutant load reductions and costs for the recommended SCMs. The findings from that assessment are documented in HW's Stormwater Control Measure Evaluations memorandum, dated December 2024.

Following HW's SCM evaluation, MRWC and the WBP stakeholder committee selected Costello Park and Andover High School to carry forward to conceptual design. HW then developed 10% conceptual designs for four SCMs at the two sites. The conceptual designs presented herein represent planning-level recommendations for stormwater management improvements at each site, along with planning-level estimates of costs[2] and pollutant load reduction[3].

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[1] Stormwater Control Measures (SCMs) are structural or nonstructural techniques, including green stormwater infrastructure, designed to prevent or reduce the discharge of stormwater pollutants to surface water or groundwater. The term is often used synonymously with Best Management Practice (BMP) and has become the preferred term for stormwater management regulations in Massachusetts.

[2] Planning-level costs were estimated using EPA Region 1 (2016) *Methodology for Developing Cost Estimates for Opti-Tool*, NHDOT and MassDOT unit prices, and best professional judgement. Costs include 30% contingency and are expressed in 2024 dollars.

[3] Total nitrogen (TN), total phosphorus (TP), and total suspended solids (TSS) load reductions were estimated using methodology from the MA MS4 Permit Appendix F Attachment 3 and EPA Region 1 BMP Accounting and Tracking Tool. Bacteria load reduction was estimated using methodology from Tisbury MA (2019) *Planning Level GI SCM Performance Curves for Estimating Cumulative Reductions in SW-Related Indicator Bacteria*.

CONCEPTUAL DESIGNS

Costello Park, Lawrence, MA

Existing Site Description

Existing conditions at Costello Park are shown in **Figure 1**.

- **Location:** Costello Park is located on Shawsheen Road in Lawrence. The site is bounded by Shawsheen Road to the northwest, Loring St to the northeast, the Shawsheen River to the southeast, and wooded public land to the south.
- **Land Use**: Costello Park is a city-owned park situated within a dense multifamily residential neighborhood, along a route abutting the Shawsheen River floodplain to the South Lawrence East Elementary School. A gravel parking area (perpendicular parking) along Shawsheen Road is used mostly as overflow parking for the nearby homes. Park amenities include a paved path along Shawsheen Rd, benches, and a basketball court and handball court that are in poor condition. Groundwork Lawrence operates an urban farm and community garden in the park area close to Loring St. The Shawsheen River Trail, a paved 6-ft-wide path, runs along the southeast border of the park from Loring St. Access to the River Trail is challenging for neighborhood residents because the trail entrance is on Loring St and there is no formal path connecting Shawsheen Rd to the trail through Costello Park. There are no planned improvements for the park.
- **Drainage Area:** The drainage area to the site is approximately 2.07 acres. Existing land cover is approximately 72% impervious, consisting of paved roads and driveways, gravel parking area, roofs, and basketball court. Pervious areas consist of small pockets of lawn and garden space in the residential lots, and lawn within the park.
- **Existing Stormwater:** Three catch basins on Shawsheen Road discharge through an 8-inch PVC pipe at a granite headwall in Costello Park. Runoff continues along an informal swale down to and across the River Trail. Pedestrians walk along the flow path to the River Trail. The headwall is located approximately 140 feet upgradient of the River Trail.
- **Utilities:** A 48-inch gravity sewer traverses Costello Park in the vicinity of the granite headwall and River Trail.
- **Wetland Resource Areas**: Costello Park lies adjacent to a bordering vegetated wetland along the Shawsheen River, and within the 1% and 0.2% annual chance flood zones. Groundwork Lawrence is leading an invasives (knotweed) control program along the River Trail in this area.
- **Soils:** Soils at the site are classified by Natural Resource Conservation Service (NRCS) as Udorthents, smoothed, hydrologic soil group (HSG) A. Upgradient within the drainage area, soils are classified as Unadilla very fine sandy loam, HSG B. Both HSG A and B indicate good infiltration capacity.

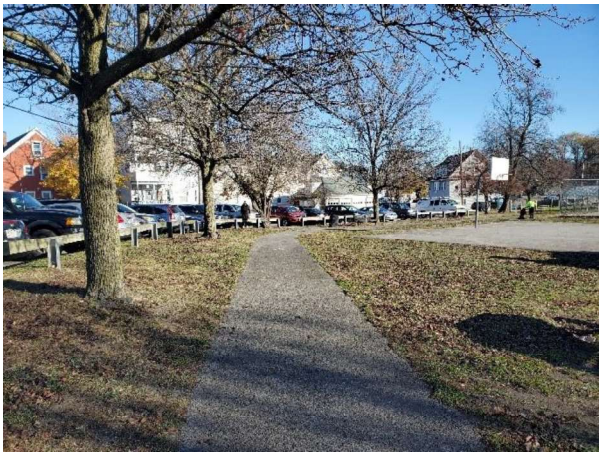

Photo 1: Parking and path along Shawsheen Road at Costello Park.

Photo 2: Catch basin on Shawsheen Rd. Three catch basins on Shawsheen Rd discharge to an outlet in Costello Park.

Photo 3: Entrance to Costello Park from Shawsheen Rd, facing southeast.

Photo 4: Granite headwall with outlet of 8-inch PVC pipe.

Photo 5: Slope below the granite headwall, facing south toward the Shawsheen River Trail.

Proposed Improvements

The proposed improvements at Costello Park are illustrated in **Figure 2**. The improvements consist of constructing a terraced infiltrating bioretention basin at the existing 8-inch drainage pipe outlet and formalizing a pedestrian path around the bioretention basin to the River Trail. The bioretention basin and formalized path will reduce stormwater pollutant loading by filtering and infiltrating runoff and preventing erosion downslope of the existing drainage pipe outlet. These improvements will also enhance aesthetics, natural habitat, and pedestrian access. The proposed improvements are further detailed below.

- Runoff discharging from the 8-inch PVC pipe will first enter the sediment forebay surfaced with a permeable concrete paver mat to collect sand, leaves, and trash for ease of maintenance. Runoff will then overtop a check dam to the terraced bioretention basin.
- The bioretention area will feature terraced cells, each with a check dam made from recycled granite curb and a stone apron. Within each cell, runoff from small storm events will filter through layers of plants, bioretention soil, and a stone reservoir, ultimately infiltrating into underlying soils. Water ponding above check dam crest will flow into the next lower cell. In the bottom cell, an overflow structure will collect runoff that ponds above the soil surface and discharge through the pipe under the River Trail to a flared end section with stone apron downgradient of the Trail.

- The bioretention basin will be planted with native plants with a mix of native herbaceous species such as broom sedge (*Andropogon virginicus*), brown-eyed susan (*Rudbeckia triloba*), swamp milkweed (*Asclepias incarnata*), cranesbill (*Geranium maculatum*), New England aster, (*Symphyotrichum novae-angliae),* and self-heal (*Prunella vulgaris*).
- A newly constructed path from Shawsheen Rd to the River Trail will guide pedestrians around the bioretention basin.

Permitting Considerations

A portion of the project may fall within the 100-ft buffer zone to bordering vegetated wetland. It also lies fully within Land Subject to Flooding. The project will therefore likely need to file a Notice of Intent for wetlands permitting with the Lawrence Conservation Commission.

Operation and Maintenance

Typical operation and maintenance (O&M) for the proposed bioretention area includes routine inspections, preventative maintenance, and corrective actions, such as the following:

1) Clean out trash, debris, and accumulated sediment from the forebay, bioretention areas, and outlet control structure.
2) Maintain vegetation (weeding, replanting, etc.) and water plants during establishment period.
3) Check for erosion within and downstream of the facility; stabilize areas of erosion, if found.
4) Check for standing water (lack of drainage) in the bioretention areas. Investigate and correct clogging if the bioretention areas do not drain within 48 hours following a rain event.

Design Summary: Costello Park Bioretention Basin

Owner: City of Lawrence
Receiving water: Shawsheen River
Drainage area: 2.07 acres
Percent impervious: 72%
Stormwater control measure(s): Infiltrating bioretention basin (1,500 sq. ft.)
Design volume (depth of runoff treated from impervious area): 0.4 inch
Estimated pollutant load reduction:

TN (lb/yr)	TP (lb/yr)	TSS (lb/yr)	Bacteria (% Removal)	Bacteria (E. coli Billion CFU/yr)
19.9	3.0	639.9	90	2,347

Estimated Costs: Construction[4]: $140,000-$160,000
Design and permitting: $40,000
Annual operation and maintenance: $3,000
20-year life cycle cost: $250,000

[4] Includes 30% contingency.

Horsley Witten Group
Sustainable Environmental Solutions

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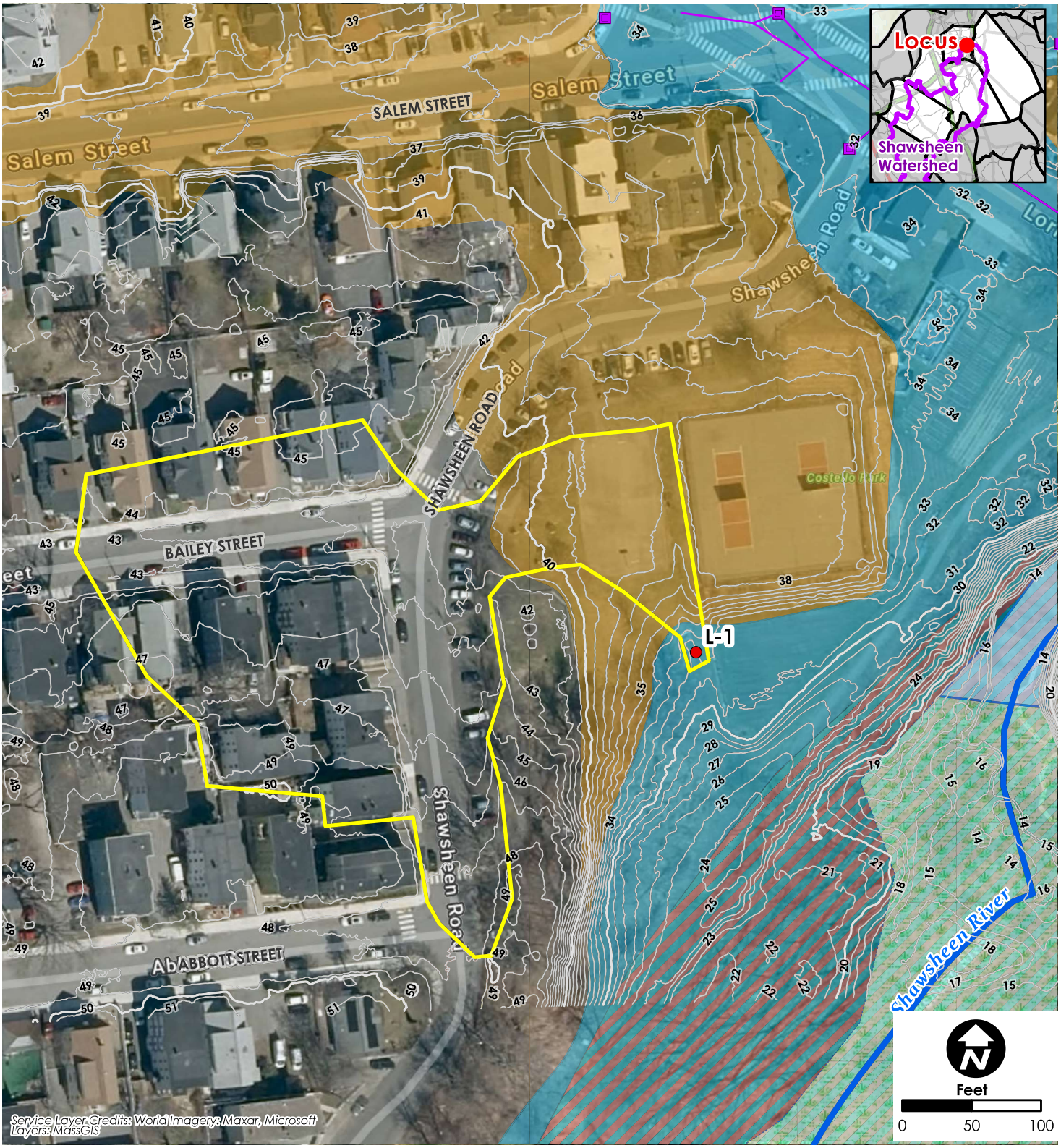


Date: 1/21/2025
Data Sources: Bureau of Geographic Information (MassGIS), ESRI

This map is for informational purposes and may not be suitable for legal, engineering, or surveying purposes.

- Survey Point
- Drainage Area

Contours
- 10 ft
- 1 ft

Drainage
- Catch Basin
- Drain Pipe

- Shawsheen River (NHD)

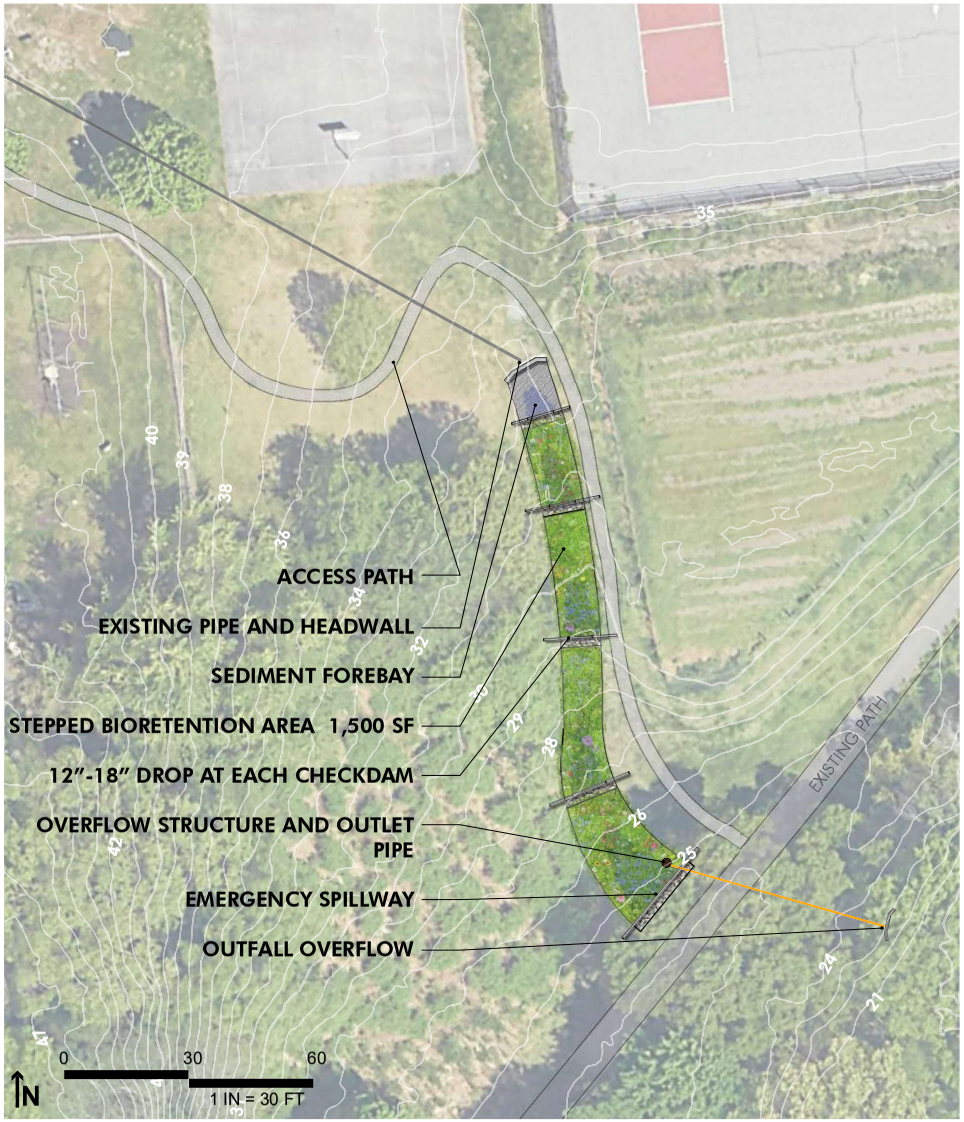
MassDEP Wetlands (2005)
- Wooded marsh
- Open Water

FEMA Prelim Flood Zones
- 1% Annual Chance Flood Hazard
- Regulatory Floodway
- 0.2% Annual Chance Flood Hazard

Shawsheen River Watershed

Figure 1
Costello Park Existing Conditions

Figure 2: Costello Park Proposed Improvements



Bioretention area (Credit HW)

Stepped Bioretention area (Credit HW)

Bioretention area (Credit HW)

Sediment Forebay with Paver Mat and Level Spreader (Credit HW)

Andover High School, Andover, MA

Existing Site Description

Existing conditions at the Andover High School east parking lot are shown in **Figure 3**.

- **Location:** Andover High School (AHS) is located at 80 Shawsheen Rd, Andover. The site for this conceptual design is the parking lot to the northeast of the high school building, adjacent to the tennis courts. The site is bounded to the north by West Middle School, to the east by Moraine St and a wooded wetland, to the south by tennis courts, and to the west by the AHS building and driveway.
- **Land Use**: AHS is a public school operated by Andover Public School District. The parking lot is in high demand and all parking spaces are used. In 2020, the school district reconfigured the parking lot, adding a bypass drive along the northern border and shifting the north parking stalls south. The reconfiguration narrowed the north drive aisle to approximately 16 ft, while keeping the south drive aisle at approximately 23 ft. The drive aisles allow for one-way traffic in a clockwise direction. Light posts are located along the center parking aisle. Andover staff noted that the north drive aisle is narrower than desired and that they would be amenable to removing the light posts and restriping the parking lot. The high school building is slated for renovations, primarily inside the building. During renovations, modular buildings will be placed on the tennis courts and south parking lot. Site work will include sidewalk improvements and repaving, including the east parking lot. There are no planned changes to drainage or circulation.
- **Drainage Area:** The drainage area to the site is approximately 1.4 acres. Existing land cover is approximately 97% impervious surface consisting of paved parking lot and sidewalks. The pervious surfaces consist of parking lot islands and a lawn strip along the tennis courts.
- **Existing Stormwater:** Three catch basins at the base of the parking lot connect into a drainage system that outfalls to a wetland to the east of the parking lot.
- **Utilities:** A water service lateral crosses the parking lot island at the base of the parking lot. Light posts are distributed along the center parking aisle.
- **Wetland Resource Areas**: The parking lot is located west of and discharges stormwater to a wooded marsh. Based on MassDEP mapping, the wetland is over 100 feet from the parking lot; however, a wetland delineation may be needed to confirm wetland boundaries. The site is not located within a floodplain or riverfront area.
- **Soils:** Soils on the site are classified by NRCS as Udorthents, smoothed, HSG A, indicating good infiltration capacity.

Photo 6: Parking lot facing west toward AHS.

Photo 7: Parking lot and sidewalks facing west.

Photo 8: Landscape island on the east end of the parking lot facing north. Location of the proposed bioretention basin.

Photo 9: Parking lot facing east.

Photo 10: View from Moraine Street facing the tennis courts, parking lot, and sidewalks.

Proposed Improvements

The proposed improvements at AHS, shown in **Figure 4**, consist of newly constructed stormwater tree trenches and a bioretention basin in the AHS east parking lot. The proposed tree trenches and bioretention basin would reduce stormwater pollutant load by filtering and infiltrating runoff from the parking lot. The improvements would also provide shade and cooling with the addition of trees and would provide educational opportunities for high school students. We assume that the tree trenches and bioretention basin would be integrated into site improvements planned following renovations of the AHS buildings. As part of the AHS renovations, we recommend slightly regrading the parking lot to redirect runoff to the proposed SCMs and removing/ replacing the existing light posts. The proposed stormwater improvements are further detailed below.

- **Center-Aisle Surface Tree Trenches.** Runoff from the northern portion of the drainage area will be directed into three surface infiltration tree trenches installed within a newly created landscape island along the center parking aisle. Curb cuts will allow runoff to first flow into sediment forebays, which will collect sediment, leaves, and trash for ease of maintenance. Runoff will then overtop a check dam within each cell to flow into the tree trench, where it will filter through layers of plants, soil, and a stone-filled infiltration trench. A standpipe and perforated pipe will promote distribution of runoff through the trench. Runoff from larger events that ponds above standpipe will exit each tree trench through a curb cut. The center aisle landscape island and surface tree trench will be planted with shade trees such as hackberry (*Celtis occidentalis*) or Kentucky coffeetree (*Gymnocladus dioicus*) and a mix of low growing grasses and native herbaceous species that can either be mown regularly or left to grow and mown seasonally.
- **Tennis Courts Subsurface Tree Trench.** Runoff from the southern portion of the parking lot will be directed toward newly installed deep sump catch basins along the southern edge of the parking lot. These catch basins will distribute pre-treated runoff into a subsurface infiltrating tree trench between the parking lot and tennis courts. A perforated pipe will distribute flows along the trench, promoting infiltration. An outlet pipe from the lowest catch basin with its invert set above the inlet will divert runoff from large storm events back into the existing closed drainage system discharging to the east. The ground above the subsurface tree trench will be surfaced with a pervious hardscape for use by tennis spectators. The subsurface tree trench will be planted with shade trees that are suitable for tennis courts, such as American hophornbeam (*Ostrya virginiana*) or black gum (*Nyssa sylvatica*). A root barrier installed between the edge of the tennis courts and the tree trench will protect the courts from root heave.
- **Parking Island Bioretention Basin.** Runoff from the east portion of the parking lot will be treated within a newly constructed bioretention basin in the existing parking island at the base (east end) of the parking lot. A surface inlet will direct runoff into a sediment forebay, which will overflow into the bioretention basin. Runoff will filter through layers of plants, mulch, bioretention soil, and stone reservoir, ultimately infiltrating into underlying soils. Runoff that ponds more than the typical 6-9 inches above the basin surface will be collected in an outlet structure conveying flow into the existing drainage system. The bioretention basin will be planted with a mix of native herbaceous species such as broom sedge (*Andropogon virginicus*), brown-eyed susan (*Rudbeckia triloba*), swamp milkweed (*Asclepias incarnata*), cranesbill (*Geranium maculatum*), and self-heal (*Prunella vulgaris*).

Permitting Considerations

A portion of the project may fall within the 100-ft buffer zone to bordering vegetated wetland. A wetland delineation may be needed, unless it has already been completed for the AHS renovations. If the project falls within the buffer zone, a Request for Determination or Notice of Intent for wetlands permitting will need to be filed with the Andover Conservation Commission.

Operation and Maintenance

Typical O&M for the proposed infiltration tree trenches and bioretention basin includes routine inspections, preventative maintenance, and corrective actions, such as the following:

1) Clean out trash, debris, and accumulated sediment from the forebays, bioretention area, and outlet control structure.
2) Maintain vegetation (weeding, replanting, pruning, etc.) and water plants during establishment period.
3) Check for erosion within and downstream of the facilities; stabilize areas of erosion, if found.
4) Check for standing water (lack of drainage) in the tree trenches and bioretention area. Investigate and correct clogging if the facilities do not drain within 48 hours following a rain event.

Design Summary: Andover High School East Parking Lot

Owner: Town of Andover
Receiving water: Isolated wetland upstream of Shawsheen River
Drainage area: 1.4 acres
Percent impervious: 97%
Stormwater control measure(s): Infiltrating tree trenches (4,000 sq. ft.) and bioretention basin (700 sq. ft.)
Design volume (depth of runoff treated from impervious area): 1 inch
Estimated pollutant load reduction

TN (lb/yr)	TP (lb/yr)	TSS (lb/yr)	Bacteria (% Removal)	Bacteria (E. coli Billion CFU/yr)
20.7	2.4	521	98%	12

Estimated Costs: Construction[5]: $350,000-$420,000 (does not include parking lot regrading and paving)
Design and permitting: $70,000
Annual operation and maintenance: $3,000
20-year life cycle cost: $520,000

[5] Includes 30% contingency.

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Sustainable Environmental Solutions

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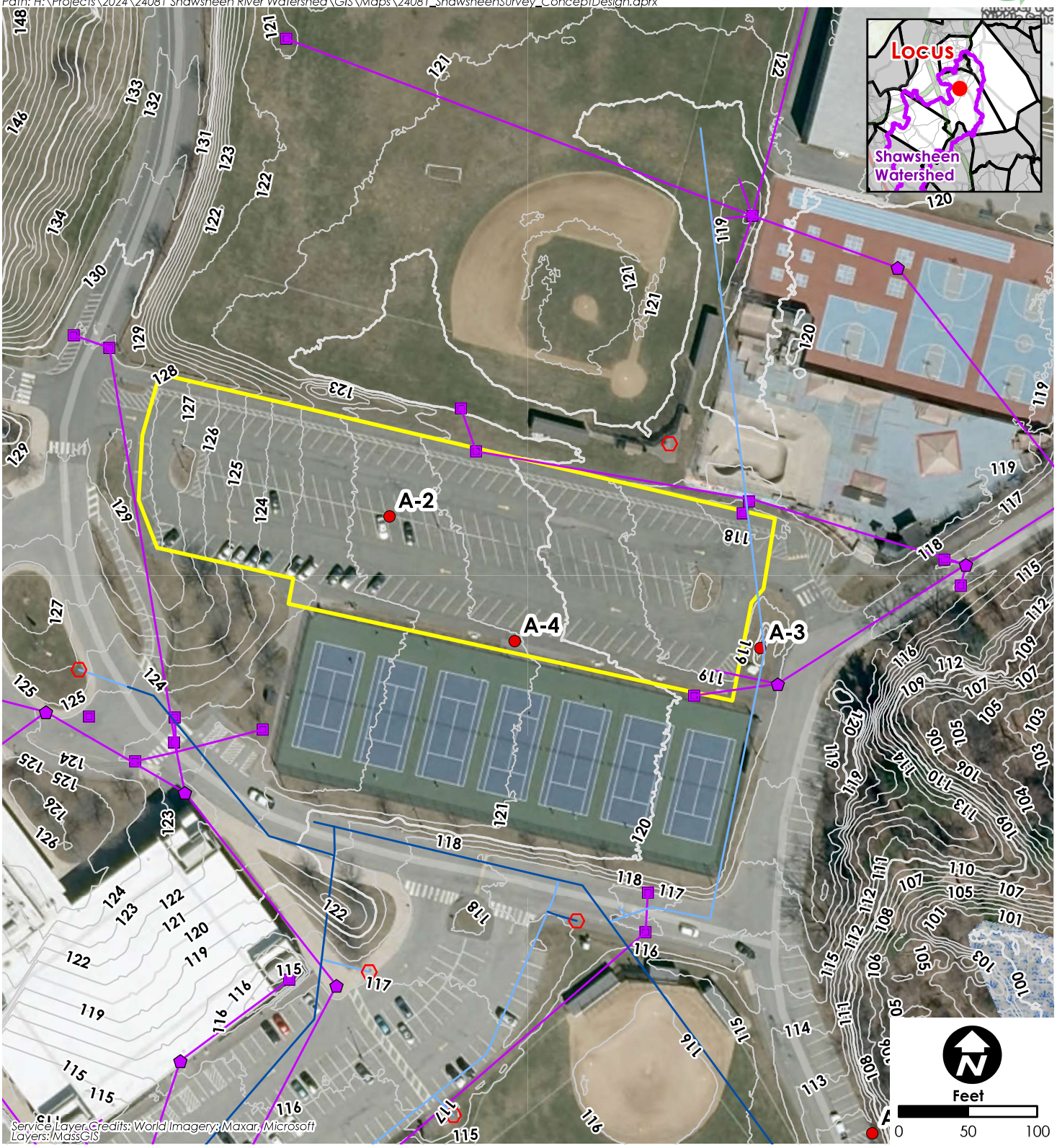

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- Survey Point
- Drainage Area
- Contours
  - 10 ft
  - 1 ft
- MassDEP Wetlands (2005)
  - Marsh/Bog
- Drainage
  - Catch Basin
  - Manhole
  - Drain Pipe
- Water
  - Hydrant
  - Lateral
  - Main

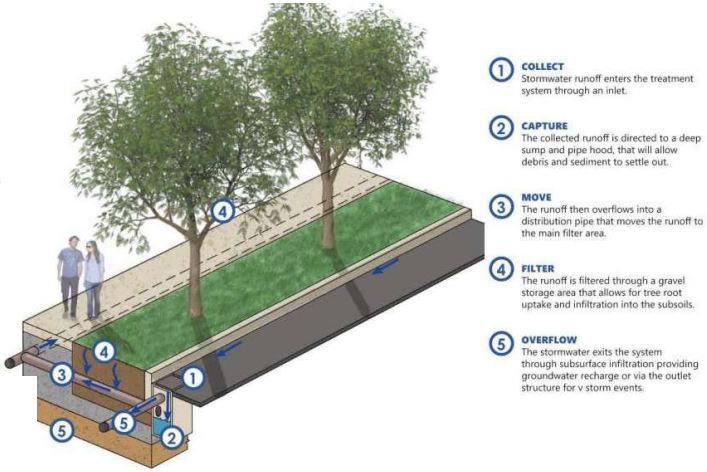
Shawsheen River Watershed

Figure 3
Andover High School Existing Conditions

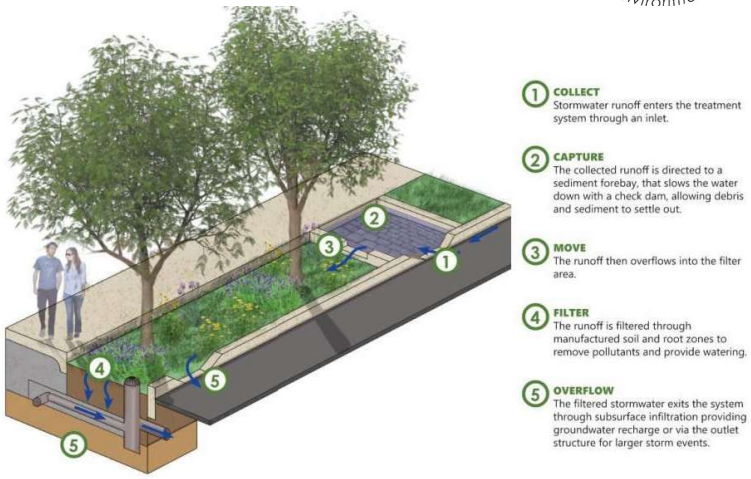
Figure 4: Andover High School Proposed Improvements

Figure 4 (cont'd): Andover High School Proposed Improvements

Bioretention Area



Sub-Surface Tree Trench



Surface Tree Trench

Sub-Surface Tree Trench (Credit HW)

Bioretention Area (Credit HW)

Surface Tree Trench (Credit HW)

Sub-surface Tree Trench with Permeable Pavers (Credit HW)